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DTC PROJECT NO. 8-CO-160-UXO-021
REPORT NO. ATC-9006

STANDARDIZED

UXO TECHNOLOGY DEMONSTRATION SITE

MOGULS SCORING RECORD NO. 572

SITE LOCATION:
U.S. ARMY ABERDEEN PROVING GROUND

DEMONSTRATOR:
PARSONS
1700 BROADWAY NO. 900
DENVER, CO 80290

TECHNOLOGY TYPE/PLATFORM:
EM61/PUSHCART

PREPARED BY:
U.S. ARMY ABERDEEN TEST CENTER
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AUGUST 2005

Prepared for:
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14. ABSTRACT
This scoring record documents the efforts of Parsons to detect and discriminate inert unexploded ordnance (UXO) utilizing the APG Standardized UXO Technology Demonstration Site Mogul. The scoring record was coordinated by Larry Overbay and the Standardized UXO Technology Demonstration Site Scoring Committee. Organizations on the committee include the U.S. Army Corps of Engineers, the Environmental Security Technology Certification Program, the Strategic Environmental Research and Development Program, the Institute for Defense Analysis, the U.S. Army Environmental Center, and the U.S. Army Aberdeen Test Center.

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SECTION 1. GENERAL INFORMATION

1.1 BACKGROUND

Technologies under development for the detection and discrimination of unexploded ordnance (UXO) require testing so that their performance can be characterized. To that end, Standardized Test Sites have been developed at Aberdeen Proving Ground (APG), Maryland and U.S. Army Yuma Proving Ground (YPG), Arizona. These test sites provide a diversity of geology, climate, terrain, and weather as well as diversity in ordnance and clutter. Testing at these sites is independently administered and analyzed by the government for the purposes of characterizing technologies, tracking performance with system development, comparing performance of different systems, and comparing performance in different environments.

The Standardized UXO Technology Demonstration Site Program is a multi-agency program spearheaded by the U.S. Army Environmental Center (AEC). The U.S. Army Aberdeen Test Center (ATC) and the U.S. Army Corps of Engineers Engineering Research and Development Center (ERDC) provide programmatic support. The program is being funded and supported by the Environmental Security Technology Certification Program (ESTCP), the Strategic Environmental Research and Development Program (SERDP) and the Army Environmental Quality Technology Program (EQT).

1.2 SCORING OBJECTIVES

The objective in the Standardized UXO Technology Demonstration Site Program is to evaluate the detection and discrimination capabilities of a given technology under various field and soil conditions. Inert munitions and clutter items are positioned in various orientations and depths in the ground.

The evaluation objectives are as follows:

a. To determine detection and discrimination effectiveness under realistic scenarios that vary targets, geology, clutter, topography, and vegetation.

b. To determine cost, time, and manpower requirements to operate the technology.

c. To determine demonstrator's ability to analyze survey data in a timely manner and provide prioritized "Target Lists" with associated confidence levels.

d. To provide independent site management to enable the collection of high quality, ground-truth, geo-referenced data for post-demonstration analysis.

1.2.1 Scoring Methodology

a. The scoring of the demonstrator's performance is conducted in two stages. These two stages are termed the RESPONSE STAGE and DISCRIMINATION STAGE. For both stages, the probability of detection (P_d) and the false alarms are reported as receiver-operating

characteristic (ROC) curves. False alarms are divided into those anomalies that correspond to emplaced clutter items, measuring the probability of false positive (P_{fp}), and those that do not correspond to any known item, termed background alarms.

b. The RESPONSE STAGE scoring evaluates the ability of the system to detect emplaced targets without regard to ability to discriminate ordnance from other anomalies. For the blind grid RESPONSE STAGE, the demonstrator provides the scoring committee with a target response from each and every grid square along with a noise level below which target responses are deemed insufficient to warrant further investigation. This list is generated with minimal processing and, since a value is provided for every grid square, will include signals both above and below the system noise level.

c. The DISCRIMINATION STAGE evaluates the demonstrator's ability to correctly identify ordnance as such and to reject clutter. For the blind grid DISCRIMINATION STAGE, the demonstrator provides the scoring committee with the output of the algorithms applied in the discrimination-stage processing for each grid square. The values in this list are prioritized based on the demonstrator's determination that a grid square is likely to contain ordnance. Thus, higher output values are indicative of higher confidence that an ordnance item is present at the specified location. For digital signal processing, priority ranking is based on algorithm output. For other discrimination approaches, priority ranking is based on human (subjective) judgment. The demonstrator also specifies the threshold in the prioritized ranking that provides optimum performance, (i.e. that is expected to retain all detected ordnance and rejects the maximum amount of clutter).

d. The demonstrator is also scored on EFFICIENCY and REJECTION RATIO, which measures the effectiveness of the discrimination stage processing. The goal of discrimination is to retain the greatest number of ordnance detections from the anomaly list, while rejecting the maximum number of anomalies arising from non-ordnance items. EFFICIENCY measures the fraction of detected ordnance retained after discrimination, while the REJECTION RATIO measures the fraction of false alarms rejected. Both measures are defined relative to performance at the demonstrator-supplied level below which all responses are considered noise, i.e., the maximum ordnance detectable by the sensor and its accompanying false positive rate or background alarm rate.

e. Based on configuration of the ground truth at the standardized sites and the defined scoring methodology, there exists the possibility of having anomalies within overlapping halos and/or multiple anomalies within halos. In these cases, the following scoring logic is implemented:

(1) In situations where multiple anomalies exist within a single R_{halo}, the anomaly with the strongest response or highest ranking will be assigned to that particular ground truth item.

(2) For overlapping R_{halo} situations, ordnance has precedence over clutter. The anomaly with the strongest response or highest ranking that is closest to the center of a particular ground truth item gets assigned to that item. Remaining anomalies are retained until all matching is complete.

(3) Anomalies located within any R_{halo} that do not get associated with a particular ground truth item are thrown out and are not considered in the analysis.

f. All scoring factors are generated utilizing the Standardized UXO Probability and Plot Program, version 3.1.1.

1.2.2 Scoring Factors

Factors to be measured and evaluated as part of this demonstration include:

a. Response Stage ROC curves:

(1) Probability of Detection (P_d^{res}).

(2) Probability of False Positive (P_{fp}^{res}).

(3) Background Alarm Rate (BAR^{res}) or Probability of Background Alarm (P_{BA}^{res}).

b. Discrimination Stage ROC curves:

(1) Probability of Detection (P_d^{disc}).

(2) Probability of False Positive (P_{fp}^{disc}).

(3) Background Alarm Rate (BAR^{disc}) or Probability of Background Alarm (P_{BA}^{disc}).

c. Metrics:

(1) Efficiency (E).

(2) False Positive Rejection Rate (R_{fp}).

(3) Background Alarm Rejection Rate (R_{BA}).

d. Other:

(1) Probability of Detection by Size and Depth.

(2) Classification by type (i.e., 20-, 40-, 105-mm, etc.).

(3) Location accuracy.

(4) Equipment setup, calibration time and corresponding man-hour requirements.

(5) Survey time and corresponding man-hour requirements.

(6) Reacquisition/resurvey time and man-hour requirements (if any).

(7) Downtime due to system malfunctions and maintenance requirements.

1.3 STANDARD AND NONSTANDARD INERT ORDNANCE TARGETS

The standard and nonstandard ordnance items emplaced in the test areas are listed in Table 1. Standardized targets are members of a set of specific ordnance items that have identical properties to all other items in the set (caliber, configuration, size, weight, aspect ratio, material, filler, magnetic remanence, and nomenclature). Nonstandard targets are inert ordnance items having properties that differ from those in the set of standardized targets.

TABLE 1. INERT ORDNANCE TARGETS

Standard Type	Nonstandard (NS)
20-mm Projectile M55	20-mm Projectile M55
	20-mm Projectile M97
40-mm Grenades M385	40-mm Grenades M385
40-mm Projectile MKII Bodies	40-mm Projectile M813
BDU-28 Submunition	
BLU-26 Submunition	
M42 Submunition	
57-mm Projectile APC M86	
60-mm Mortar M49A3	60-mm Mortar (JPG)
	60-mm Mortar M49
2.75-inch Rocket M230	2.75-inch Rocket M230
	2.75-inch Rocket XM229
MK 118 ROCKEYE	
81-mm Mortar M374	81-mm Mortar (JPG)
	81-mm Mortar M374
105-mm HEAT Rounds M456	
105-mm Projectile M60	105-mm Projectile M60
155-mm Projectile M483A1	155-mm Projectile M483A
	500-lb Bomb

JPG = Jefferson Proving Ground
HEAT = high-explosive antitank

SECTION 2. DEMONSTRATION

2.1 DEMONSTRATOR INFORMATION

2.1.1 Demonstrator Point of Contact (POC) and Address

Parsons
1700 Broadway No. 900
Denver, CO 80290

2.1.2 System Description (provided by demonstrator)

Parsons will locate and flag detectable anomalies at the Standardized Test Sites (except the Active Response Area) using electromagnetic (EM) detection systems. Locations of detected anomalies will be surveyed and results reported on "dig sheets".

Parsons will mobilize two, two-man EM crews to APG with a geophysicist, and safely locate detectable anomalies using electromagnetic systems (Geonics EM61-MKII) (fig.1) within the Standardized UXO Technology Demonstration Site at APG, including the Blind Grid (0.48 acres), Open Field (13.68 acres), Moguls (1.3 acres), and Wooded (1.35 acres) areas, but not including the Active Response Area (3.5 acres). As each anomaly is detected, its location will be marked by a pin flag.

Figure 1. Demonstrator's system, EM61/pushcart.

A two-man Survey Crew will next survey the flagged locations of detected anomalies using a Real-Time Kinematic (RTK) Global Positioning System (GPS) instrument. Locations will be recorded in Universal Transverse Mercator (UTM) coordinates on the Standardized UXO

Technology Demonstration Site Program Reporting Spreadsheets (Dig Sheets). The Survey Crew will use a Trimble 5700 RTK-GPS survey instrument in the open field, blind grid, and moguls; and a Trimble Total Station for the wooded areas (where GPS coverage is not available).

2.1.3 Data Processing Description (provided by demonstrator)

The process for detection of anomalies using a electromagnetic detection, marking with pin flags, and surveying by RTK GPS is described as follows. At the outset, lanes will be set up to organize work activities. The lanes will be set up on a 100x100 m grid basis and each grid will then be subdivided into lanes that are 1 m wide. The lanes will be marked using ropes stretched between tape measures. Each team will proceed slowly along the lane with the EM61-MK II until the operator detects an anomaly. The anomaly location will then be refined by traversing over the anomaly in at least two different orientations. Once the position of the anomaly has been determined, the second member of the team will place an annotated flag at the location. He will then note the anomaly amplitude in a field book, as well as the lane that the anomaly was found in and the approximate distance along the lane. Once a lane has been completed the team will move to next lane in the grid. Once all the lanes in the grid have been traversed then the team will move on to the next grid.

Once a grid has been completed, then it will become available for surveying. The surveying team will use either a Trimble 5700 or equivalent RTK GPS system for areas where vegetation doesn't prevent the use of GPS, or a Trimble Total Station in areas of dense vegetation. When using the GPS, the instrument will be placed over each flag and location recorded in a digital data logger. The assistant will then remove the flag. In the case of wooded areas, the assistant will place the rod over the flags in the wooded areas and once the operator of the total station indicates that a reading has been acquired, then the assistant will remove the flag and proceed to the next point.

2.1.4 Data Submission Format

Data were submitted for scoring in accordance with data submission protocols outlined in the Standardized UXO Technology Demonstration Site Handbook. These submitted data are not included in this report in order to protect ground truth information.

2.1.5 Demonstrator Quality Assurance (QA) and Quality Control (QC) (provided by demonstrator)

General. Parsons' Quality Assurance (QA) program consists of an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that the product meets defined standards of quality with a stated level of confidence. Parsons QA/Quality Control (QC) program establishes the methods and procedures that will be used during the project, and is subdivided into two parts as follows:

- Personnel and Operating Procedure QA/QC; and.
- Instrument/Equipment QA/QC.

Data Quality Objectives. This project is being conducted to establish the baseline standards of performance for the historical standards of industry for Ordnance and Explosives (OE) detection (electromagnetic detection, and magnetic detection). The data quality objective is to emulate as much as possible the historical methods and data quality achieved historically during normal operation of electromagnetic detection of OE.

Personnel and Operating Procedure QA/QC. Field QA/QC will be the responsibility of the Senior Geophysicist for the EM detection and survey activities. Field personnel will be geophysicists and operators with experience in the EM and flag (dig) from the U.S. Navy Kaho'olawe Island site where the EM and flag method was used extensively and found to be the most effective method at detecting buried metallic objects, or other location. Personnel will have received training on the equipment that they are operating.

The operators will be familiarized with site conditions by locating anomalies within the calibration lanes on two occasions. The first time will be without any indication of where the buried items are located. This will ensure that they detect all detectable items present. Once they have successfully performed this task, they will repeat the calibration lanes strip with the actual locations of the buried items marked on the surface. This will allow them to refine their positional marking techniques. Once they have completed these two steps, then the teams can proceed to acquisition over the remainder of the site.

Instrument/Equipment QA/QC:

Testing Procedures and Frequency. Instruments and equipment used to locate anomalies and generate survey coordinates will be tested with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications.

Function Test. At least twice daily, all geophysical instruments will be function checked by one of two methods. The operational and test procedures will conform to manufacturer's standard instructions. This field test will ensure that the equipment is functioning within the allowable tolerances.

One method is performed by measuring the instrument response over the daily test grid and comparing that response to its standard response recorded prior to being placed in service. For this EE/CA, USA will establish a test grid, containing no less than two seed items, near the site trailer. Use of equipment that deviates by more than 25 percent from the standard response will be discontinued and the equipment will be repaired or replaced. The second method is performed by placing a small metallic test object on the ground in a standard orientation and centered beneath the equipment sensors. The instrument's response is recorded and compared to its initial response measured over the same object prior to being placed in service. For this project, trailer ball hitches will be used as the test objects. If the response in the field is greater than 20-percent of the initial response, the instrument will be repaired or removed from service.

Preventive Maintenance. Equipment, instruments, tools, gauges, and other items requiring preventive maintenance will be serviced prior in accordance with the manufacturer's specified recommendations. Any anomalies in the instrumentation that affect the survey will be noted and the instrument replaced by the vendor. No other maintenance procedures will be used, other than charging the batteries and ensuring that the connectors stay dry.

Survey Data Quality Control:

Data Acquisition. Parsons' Quality Control program ensures the precision and accuracy of analyses by detecting errors and preventing recurrences or measuring the degree of error inherent in the activities and procedures. Any raw data from survey measurements will be appropriately recorded and notated in the field notebooks or Data Loggers.

Quality control will be conducted for all hardcopy (Dig Sheets) and electronic deliverables. At a minimum the following measures will be conducted:

- Standard coordinate systems (UTM) will be used and verified throughout the project.
- All deliverables will be peer reviewed to ensure accuracy.
- Electronic data will be backed up periodically.

Corrective Action. The following procedures have been established to assure that conditions adverse to quality such as malfunctions, deficiencies, deviations, and errors are promptly investigated, documented, evaluated, and corrected.

When a significant condition adverse to quality is noted in the field, the cause of the condition will be determined and corrective action taken to preclude repetition. Condition identification, cause, reference documents, and corrective action planned will be documented and reported to the Site Geophysicist. Implementation of corrective actions will be verified by documented follow-up action. All project personnel have the daily responsibility to promptly identify problem areas, solicit approved corrective actions, and report any condition adverse to quality.

Corrective actions will be initiated at a minimum:

- When predetermined acceptance standards are not attained.
- When procedures or data compiled are determined to be faulty.
- When equipment or instrumentation is found faulty.
- When quality assurance requirements are violated.
- As a result of system and performance audits.
- As a result of management assessment.

Field Investigation Recordkeeping:

Daily Field Activity Records. Field activity logbooks will be maintained daily, if applicable, and all entries will be recorded in ink. All personnel will use bound and numbered field logbooks with consecutively numbered pages. The following logs will be maintained.

Daily Activity Log:

- Date and recorder of field information;
- Start and end time of work activities including breaks, lunch, and down times;
- Visitors;
- Weather conditions;
- Relevant events;
- Important phone calls;
- Changes from approved or planned work instructions; and
- Signature of the on-site QA/QC Manager.

Safety Log:

- Date and recorder of log,
- Tailgate safety briefing (time conducted and by whom),
- Weather conditions,
- Significant site events relating to safety,
- Accidents, and
- Stop work due to safety,

Demonstrator's Field Personnel. Six personnel total will be used as follows:

- Two geophysical crews each consisting of one Geophysicist and one Geophysics assistant.
- One Survey crew consisting of one Lead Surveyor and one Surveyor Assistant.

Support Equipment Required. Temporary storage space is required for overnight storage of instruments and equipment during the work.

Frequency and Radio Utilization. The Trimble GPS RTK system utilizes radio communication to transmit information from the GPS base station to the rover units. The radio can utilize a range of frequencies of .25 MHz in one of three bandwidths (410-420 MHz, 430-450 MH, or 450-470 MHz. This portion of the frequency spectrum is commonly used for accurate GPS positioning in geophysical surveying. One of the frequencies that has minimal interference from other sources will be selected and will transmit a data pulse every 1 s for a majority of the work day. The radio, which is only capable of data transmission from the GPS base station (no voice transmission), has a selectable power output of 2, 10 or 25 W. The radio licenses are held by the vendor that will supply the equipment to Parsons.

2.1.6 Additional Records

The following record(s) by this vendor can be accessed via the Internet as MicroSoft Word documents at www.uxotestsites.org. The counterparts to this report are the Blind Grid, Scoring Record No. 252, the Open Field, Scoring Record No. 411, and the Woods, Scoring Record No. 496.

2.2 APG SITE INFORMATION

2.2.1 Location

The APG Standardized Test Site is located within a secured range area of the Aberdeen Area. The Aberdeen Area of APG is located approximately 30 miles northeast of Baltimore at the northern end of the Chesapeake Bay. The Standardized Test Site encompasses 17 acres of upland and lowland flats, woods and wetlands.

2.2.2 Soil Type

According to the soils survey conducted for the entire area of APG in 1998, the test site consists primarily of Elkton Series type soil (ref 2). The Elkton Series consist of very deep, slowly permeable, poorly drained soils. These soils formed in silty aeolin sediments and the underlying loamy alluvial and marine sediments. They are on upland and lowland flats and in depressions of the Mid-Atlantic Coastal Plain. Slopes range from 0 to 2 percent.

ERDC conducted a site-specific analysis in May of 2002 (ref 3). The results basically matched the soil survey mentioned above. Seventy percent of the samples taken were classified as silty loam. The majority (77 percent) of the soil samples had a measured water content between 15- and 30-percent with the water content decreasing slightly with depth.

For more details concerning the soil properties at the APG test site, go to www.uxotestsites.org on the web to view the entire soils description report.

2.2.3 Test Areas

A description of the test site areas at APG is included in Table 2.

TABLE 2. TEST SITE AREAS

Area	Description
Calibration Grid	Contains 14 standard ordnance items buried in six positions at various angles and depths to allow demonstrator to calibrate their equipment.
Blind Test Grid	Contains 400 grid cells in a 0.2-hectare (0.5 acre) site. The center of each grid cell contains ordnance, clutter or nothing.
Open Field	A 4-hectare (10-acre) site containing open areas, dips, ruts and obstructions that challenge platform systems or hand held detectors. The challenges include a gravel road, wet areas and trees. The vegetation height varies from 15 to 25 cm.
Moguls	1.30-acre area consisting of two areas (the rectangular or driving portion of the course and the triangular section with more difficult, non-drivable terrain). A series of craters (as deep as 0.91m) and mounds (as high as 0.91m) encompass this section.

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SECTION 3. FIELD DATA

3.1 DATE OF FIELD ACTIVITIES (21 and 22 September 2004)

3.2 AREAS TESTED/NUMBER OF HOURS

Areas tested and total number of hours operated at each site are summarized in Table 3.

TABLE 3. AREAS TESTED AND NUMBER OF HOURS

Area	Number of Hours
Calibration Lanes	1.33
Mogul	15.00

3.3 TEST CONDITIONS

3.3.1 Weather Conditions

An APG weather station located approximately one mile west of the test site was used to record average temperature and precipitation on a half hour basis for each day of operation. The temperatures listed in Table 4 represent the average temperature during field operations from 0700 to 1700 hours while precipitation data represents a daily total amount of rainfall. Hourly weather logs used to generate this summary are provided in Appendix B.

TABLE 4. TEMPERATURE/PRECIPITATION DATA SUMMARY

Date, 2004	Average Temperature, ^{o}F	Total Daily Precipitation, in.
September 21	73.12	0.00
September 22	77.30	0.00

3.3.2 Field Conditions

Parsons surveyed the moguls on 21 and 22 September 2004. The moguls had small amounts of standing water from rain prior to testing.

3.3.3 Soil Moisture

Three soil probes were placed at various locations within the site to capture soil moisture data: Blind Grid, Calibration, Open Field, and Wooded areas. Measurements were collected in percent moisture and were taken twice daily (morning and afternoon) from five different soil depths (1 to 6 in., 6 to 12 in., 12 to 24 in., 24 to 36 in., and 36 to 48 in.) from each probe. Soil moisture logs are included in Appendix C.

3.4 FIELD ACTIVITIES

3.4.1 Setup/Mobilization

These activities included initial mobilization and daily equipment preparation and break down. A three-person crew took 1-hour and 40 minutes to perform the initial setup and mobilization. There was 1-hour and 35 minutes of daily equipment preparation and end of the day equipment break down lasted 1-hour and 10 minutes.

3.4.2 Calibration

Parsons spent a total of 1-hour and 20 minutes in the calibration lanes, of which 55 minutes was spent collecting data. An additional 15 minutes was spent calibrating in the moguls

3.4.3 Downtime Occasions

Occasions of downtime are grouped into five categories: equipment/data checks or equipment maintenance, equipment failure and repair, weather, Demonstration Site issues, or breaks/lunch. All downtime is included for the purposes of calculating labor costs (section 5) except for downtime due to Demonstration Site issues. Demonstration Site issues, while noted in the Daily Log, are considered non-chargeable downtime for the purposes of calculating labor costs and are not discussed. Breaks and lunches are discussed in this section and billed to the total Site Survey area.

3.4.3.1 Equipment/data checks, maintenance. Equipment data checks and maintenance activities accounted for no site usage time. These activities included changing out batteries and routine data checks to ensure the data was being properly recorded/collected. Parsons spent an additional 2 hours and 55 minutes for breaks and lunches.

3.4.3.2 Equipment failure or repair. No time was needed to resolve equipment failures that occurred while surveying the Mogul.

3.4.3.3 Weather. No weather delays occurred during the survey.

3.4.4 Data Collection

Parsons spent a total time of 15 hours in the Mogul area, 9 hours and 20 minutes of which was spent collecting data.

3.4.5 Demobilization

The Parsons survey crew went on to conducted a full demonstration of the site. Therefore, demobilization did not occur until 23 September 2004. On that day, it took the crew 55 minutes to break down and pack up their equipment.

3.5 PROCESSING TIME

Parsons submitted the raw data from the demonstration activities on the last day of the demonstration, as required. The scoring submittal data was also provided within the required 30-day timeframe.

3.6 DEMONSTRATOR'S FIELD SURVEYING METHOD

Parsons surveyed the moguls in a linear fashion. Parsons started in the southeast corner and surveyed in a west to east direction. When a potential target was discovered, a flag was placed in the ground. A two person survey crew then used a RTK Trimble GPS station to get the coordinate of the item.

3.7 SUMMARY OF DAILY LOGS

Daily logs capture all field activities during this demonstration and are located in Appendix D. Activities pertinent to this specific demonstration are indicated in highlighted text.

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SECTION 4. TECHNICAL PERFORMANCE RESULTS

4.1 ROC CURVES USING ALL ORDNANCE CATEGORIES

(Not applicable for this technology)

4.2 ROC CURVES USING ORDNANCE LARGER THAN 20 MM

(Not applicable for this technology)

4.3 PERFORMANCE SUMMARIES

Results for the Mogul Area test broken out by size, depth and nonstandard ordnance are presented in Table 5 (for cost results, see section 5). Results by size and depth include both standard and nonstandard ordnance. The results by size show how well the demonstrator did at detecting/discriminating ordnance of a certain caliber range (see app A for size definitions). The results are relative to the number of ordnance items emplaced.

The RESPONSE STAGE results are derived from the list of anomalies above the demonstrator-provided noise level. The results for the DISCRIMINATION STAGE are derived from the demonstrator's recommended threshold for optimizing UXO field cleanup by minimizing false digs and maximizing ordnance recovery. The lower 90 percent confidence limit on probability of detection and P_{fp} was calculated assuming that the number of detections and false positives are binomially distributed random variables. All results in Table 5 have been rounded to protect the ground truth. However, lower confidence limits were calculated using actual results.

TABLE 5. SUMMARY OF MOGUL RESULTS FOR EM61/PUSHCART

Metric	Overall	Standard	Nonstandard	By Size			By Depth, m		
				Small	Medium	Large	< 0.3	0.3 to <1	>= 1
RESPONSE STAGE									
P_d	0.35	0.40	0.25	0.25	0.40	0.45	0.40	0.30	0.10
P_d Low 90% Conf	0.29	0.33	0.19	0.20	0.31	0.32	0.35	0.23	0.02
P_d Upper 90% Conf	0.39	0.46	0.34	0.33	0.48	0.60	0.49	0.40	0.22
P_{fp}	0.40	-	-	-	-	-	0.45	0.35	0.20
P_{fp} Low 90% Conf	0.37	-	-	-	-	-	0.43	0.28	0.06
P_{fp} Upper 90% Conf	0.43	-	-	-	-	-	0.51	0.38	0.49
BAR	0.30	-	-	-	-	-	-	-	-
DISCRIMINATION STAGE									
P_d	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Low 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Upper 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{fp}	N/A	-	-	-	-	-	N/A	N/A	N/A
P_{fp} Low 90% Conf	N/A	-	-	-	-	-	N/A	N/A	N/A
P_{fp} Upper 90% Conf	N/A	-	-	-	-	-	N/A	N/A	N/A
BAR	N/A	-	-	-	-	-	-	-	-

Response Stage Noise Level: 0.00
Recommended Discrimination Stage Threshold: 0.00

Note: The recommended discrimination stage threshold values are provided by the demonstrator.
No discrimination algorithm was applied. Therefore, the discrimination stage results are not applicable.

4.4 EFFICIENCY, REJECTION RATES, AND TYPE CLASSIFICATION

Due to technical limitations of the system used for this demonstration, no attempt was made to discriminate. Therefore, the following tables presented in this section are not applicable.

Efficiency and rejection rates are calculated to quantify the discrimination ability at specific points of interest on the ROC curve: (1) at the point where no decrease in P_d is suffered (i.e., the efficiency is by definition equal to one) and (2) at the operator selected threshold. These values are reported in Table 6.

TABLE 6. EFFICIENCY AND REJECTION RATES

	Efficiency (E)	False Positive Rejection Rate	Background Alarm Rejection Rate
At Operating Point	N/A	N/A	N/A
With No Loss of P_d	N/A	N/A	N/A

At the demonstrator's recommended setting, the ordnance items that were detected and correctly discriminated were further scored on whether their correct type could be identified (table 7). Correct type examples include "20-mm projectile, 105-mm HEAT Projectile, and 2.75-inch Rocket". A list of the standard type declaration required for each ordnance item was provided to demonstrators prior to testing. For example, the standard type for the three example items are 20mmP, 105H, and 2.75in, respectively.

TABLE 7. CORRECT TYPE CLASSIFICATION OF TARGETS CORRECTLY DISCRIMINATED AS UXO

Size	Percentage Correct
Small	N/A
Medium	N/A
Large	N/A
Overall	N/A

4.5 LOCATION ACCURACY

The mean location error and standard deviations appear in Table 8. These calculations are based on average missed depth for ordnance correctly identified in the discrimination stage. Depths are measured from the closest point of the ordnance to the surface. For the Blind Grid, only depth errors are calculated, since (X, Y) positions are known to be the centers of each grid square.

TABLE 8. MEAN LOCATION ERROR AND STANDARD DEVIATION (M)

	Mean	Standard Deviation
Northing	0.01	0.18
Easting	0.01	0.22
Depth	N/A	N/A

Note: Demonstrator did not attempt to declare depth of detection.

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SECTION 5. ON-SITE LABOR COSTS

A standardized estimate for labor costs associated with this effort was calculated as follows: the first person at the test site was designated "supervisor", the second person was designated "data analyst", and the third and following personnel were considered "field support". Standardized hourly labor rates were charged by title: supervisor at $95.00/hour, data analyst at $57.00/hour, and field support at $28.50/hour.

Government representatives monitored on-site activity. All on-site activities were grouped into one of ten categories: initial setup/mobilization, daily setup/stop, calibration, collecting data, downtime due to break/lunch, downtime due to equipment failure, downtime due to equipment/data checks or maintenance, downtime due to weather, downtime due to demonstration site issue, or demobilization. See Appendix D for the daily activity log. See section 3.4 for a summary of field activities.

The standardized cost estimate associated with the labor needed to perform the field activities is presented in Table 9. Note that calibration time includes time spent in the Calibration Lanes as well as field calibrations. "Site survey time" includes daily setup/stop time, collecting data, breaks/lunch, downtime due to equipment/data checks or maintenance, downtime due to failure, and downtime due to weather.

TABLE 9. ON-SITE LABOR COSTS

	No. People	Hourly Wage	Hours	Cost
Initial Setup				
Supervisor	1	$95.00	1.66	$157.70
Data Analyst	1	57.00	1.66	94.62
Field Support	1	28.50	1.66	47.31
SubTotal				**$299.63**
Calibration				
Supervisor	1	$95.00	1.58	$150.10
Data Analyst	1	57.00	1.58	90.06
Field Support	1	28.50	1.58	45.03
SubTotal				**$285.19**
Site Survey				
Supervisor	1	$95.00	15.00	$1,425.00
Data Analyst	1	57.00	15.00	855.00
Field Support	1	28.50	15.00	427.50
SubTotal				**$2,707.50**

See notes at end of table.

TABLE 9 (CONT'D)

	No. People	Hourly Wage	Hours	Cost
Demobilization				
Supervisor	1	$95.00	0.92	$87.40
Data Analyst	1	57.00	0.92	52.44
Field Support	3	28.50	0.92	78.66
Subtotal				**$218.50**
Total				**$3,510.82**

Notes: Calibration time includes time spent in the Calibration Lanes as well as calibration before each data run.

Site Survey time includes daily setup/stop time, collecting data, breaks/lunch, downtime due to system maintenance, failure, and weather.

SECTION 6. COMPARISON OF RESULTS TO OPEN FIELD DEMONSTRATION

6.1 SUMMARY OF RESULTS FROM OPEN FIELD DEMONSTRATION

Table 10 shows the results from Open Field survey conducted prior to surveying the Moguls during the same site visit in September of 2004. For more details on the Open Field survey results reference section 2.1.6.

TABLE 10. SUMMARY OF OPEN FIELD RESULTS FOR THE EM61/PUSHCART

Metric	Overall	Standard	Nonstandard	By Size			By Depth, m		
				Small	Medium	Large	< 0.3	0.3 to <1	>= 1
RESPONSE STAGE									
P_d	0.55	0.60	0.45	0.45	0.55	0.65	0.65	0.50	0.25
P_d Low 90% Conf	0.50	0.56	0.37	0.41	0.49	0.58	0.62	0.44	0.18
P_d Upper 90% Conf	0.57	0.65	0.49	0.52	0.61	0.73	0.72	0.57	0.34
P_{fp}	0.45	-	-	-	-	-	0.40	0.45	0.45
P_{fp} Low 90% Conf	0.41	-	-	-	-	-	0.38	0.42	0.26
P_{fp} Upper 90% Conf	0.45	-	-	-	-	-	0.45	0.48	0.62
BAR	0.10	-	-	-	-	-	-	-	-
DISCRIMINATION STAGE									
P_d	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Low 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Upper 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{fp}	N/A	-	-	-	-	-	N/A	N/A	N/A
P_{fp} Low 90% Conf	N/A	-	-	-	-	-	N/A	N/A	N/A
P_{fp} Upper 90% Conf	N/A	-	-	-	-	-	N/A	N/A	N/A
BAR	N/A	-	-	-	-	-	-	-	-

6.2 COMPARISON OF ROC CURVES USING ALL ORDNANCE CATEGORIES

(Not applicable for this technology)

6.3 COMPARISON OF ROC CURVES USING ORDNANCE LARGER THAN 20 MM

(Not applicable for this technology)

6.4 STATISTICAL COMPARISONS

Statistical Chi-square significance tests were used to compare results between the Open Field and Mogul Area scenarios. The intent of the comparison is to determine if the feature introduced in each scenario has a degrading effect on the performance of the sensor system. However, any modifications in the UXO sensor system during the test, like changes in the processing or changes in the selection of the operating threshold, will also contribute to performance differences.

The Chi-square test for comparison between ratios was used at a significance level of 0.05 to compare Open Field to Mogul area with regard to P_d^{res}, P_d^{disc}, P_{fp}^{res} and P_{fp}^{disc}, Efficiency and Rejection Rate. These results are presented in Table 11. A detailed explanation and example of the Chi-square application is located in Appendix A.

TABLE 11. CHI-SQUARE RESULTS – OPEN FIELD VERSUS MOGULS

Metric	Small	Medium	Large	Overall
P_d^{res}	Significant	Significant	Not Significant	Significant
P_d^{disc}	N/A	N/A	N/A	N/A
P_{fp}^{res}	Not Significant	Not Significant	Not Significant	Not Significant
P_{fp}^{disc}	-	-	-	N/A
Efficiency	-	-	-	N/A
Rejection rate	-	-	-	N/A

SECTION 7. APPENDIXES

APPENDIX A. TERMS AND DEFINITIONS

GENERAL DEFINITIONS

Anomaly: Location of a system response deemed to warrant further investigation by the demonstrator for consideration as an emplaced ordnance item.

Detection: An anomaly location that is within R_{halo} of an emplaced ordnance item.

Emplaced Ordnance: An ordnance item buried by the government at a specified location in the test site.

Emplaced Clutter: A clutter item (i.e., non-ordnance item) buried by the government at a specified location in the test site.

R_{halo}: A pre-determined radius about the periphery of an emplaced item (clutter or ordnance) within which a location identified by the demonstrator as being of interest is considered to be a response from that item. If multiple declarations lie within R_{halo} of any item (clutter or ordnance), the declaration with the highest signal output within the R_{halo} will be utilized. For the purpose of this program, a circular halo 0.5 meters in radius will be placed around the center of the object for all clutter and ordnance items less than 0.6 meters in length. When ordnance items are longer than 0.6 meters, the halo becomes an ellipse where the minor axis remains 1 meter and the major axis is equal to the length of the ordnance plus 1 meter.

Small Ordnance: Caliber of ordnance less than or equal to 40 mm (includes 20-mm projectile, 40-mm projectile, submunitions BLU-26, BLU-63, and M42).

Medium Ordnance: Caliber of ordnance greater than 40 mm and less than or equal to 81 mm (includes 57-mm projectile, 60-mm mortar, 2.75 in. Rocket, MK118 Rockeye, 81-mm mortar).

Large Ordnance: Caliber of ordnance greater than 81 mm (includes 105-mm HEAT, 105-mm projectile, 155-mm projectile, 500-pound bomb).

Shallow: Items buried less than 0.3 meter below ground surface.

Medium: Items buried greater than or equal to 0.3 meter and less than 1 meter below ground surface.

Deep: Items buried greater than or equal to 1 meter below ground surface.

Response Stage Noise Level: The level that represents the point below which anomalies are not considered detectable. Demonstrators are required to provide the recommended noise level for the Blind Grid test area.

Discrimination Stage Threshold: The demonstrator selected threshold level that they believe provides optimum performance of the system by retaining all detectable ordnance and rejecting the maximum amount of clutter. This level defines the subset of anomalies the demonstrator would recommend digging based on discrimination.

Binomially Distributed Random Variable: A random variable of the type which has only two possible outcomes, say success and failure, is repeated for n independent trials with the probability p of success and the probability 1-p of failure being the same for each trial. The number of successes x observed in the n trials is an estimate of p and is considered to be a binomially distributed random variable.

RESPONSE AND DISCRIMINATION STAGE DATA

The scoring of the demonstrator's performance is conducted in two stages. These two stages are termed the RESPONSE STAGE and DISCRIMINATION STAGE. For both stages, the probability of detection (P_d) and the false alarms are reported as receiver operating characteristic (ROC) curves. False alarms are divided into those anomalies that correspond to emplaced clutter items, measuring the probability of false positive (P_{fp}) and those that do not correspond to any known item, termed background alarms.

The RESPONSE STAGE scoring evaluates the ability of the system to detect emplaced targets without regard to ability to discriminate ordnance from other anomalies. For the RESPONSE STAGE, the demonstrator provides the scoring committee with the location and signal strength of all anomalies that the demonstrator has deemed sufficient to warrant further investigation and/or processing as potential emplaced ordnance items. This list is generated with minimal processing (e.g., this list will include all signals above the system noise threshold). As such, it represents the most inclusive list of anomalies.

The DISCRIMINATION STAGE evaluates the demonstrator's ability to correctly identify ordnance as such, and to reject clutter. For the same locations as in the RESPONSE STAGE anomaly list, the DISCRIMINATION STAGE list contains the output of the algorithms applied in the discrimination-stage processing. This list is prioritized based on the demonstrator's determination that an anomaly location is likely to contain ordnance. Thus, higher output values are indicative of higher confidence that an ordnance item is present at the specified location. For electronic signal processing, priority ranking is based on algorithm output. For other systems, priority ranking is based on human judgment. The demonstrator also selects the threshold that the demonstrator believes will provide "optimum" system performance, (i.e., that retains all the detected ordnance and rejects the maximum amount of clutter).

Note: The two lists provided by the demonstrator contain identical numbers of potential target locations. They differ only in the priority ranking of the declarations.

RESPONSE STAGE DEFINITIONS

Response Stage Probability of Detection (P_d^{res}): P_d^{res} = (No. of response-stage detections)/ (No. of emplaced ordnance in the test site).

Response Stage False Positive (fp^{res}): An anomaly location that is within R_{halo} of an emplaced clutter item.

Response Stage Probability of False Positive (P_{fp}^{res}): P_{fp}^{res} = (No. of response-stage false positives)/(No. of emplaced clutter items).

Response Stage Background Alarm (ba^{res}): An anomaly in a blind grid cell that contains neither emplaced ordnance nor an emplaced clutter item. An anomaly location in the open field or scenarios that is outside R_{halo} of any emplaced ordnance or emplaced clutter item.

Response Stage Probability of Background Alarm (P_{ba}^{res}): Blind Grid only: P_{ba}^{res} = (No. of response-stage background alarms)/(No. of empty grid locations).

Response Stage Background Alarm Rate (BAR^{res}): Open Field only: BAR^{res} = (No. of response-stage background alarms)/(arbitrary constant).

Note that the quantities P_d^{res}, P_{fp}^{res}, P_{ba}^{res}, and BAR^{res} are functions of t^{res}, the threshold applied to the response-stage signal strength. These quantities can therefore be written as $P_d^{res}(t^{res})$, $P_{fp}^{res}(t^{res})$, $P_{ba}^{res}(t^{res})$, and $BAR^{res}(t^{res})$.

DISCRIMINATION STAGE DEFINITIONS

Discrimination: The application of a signal processing algorithm or human judgment to response-stage data that discriminates ordnance from clutter. Discrimination should identify anomalies that the demonstrator has high confidence correspond to ordnance, as well as those that the demonstrator has high confidence correspond to nonordnance or background returns. The former should be ranked with highest priority and the latter with lowest.

Discrimination Stage Probability of Detection (P_d^{disc}): P_d^{disc} = (No. of discrimination-stage detections)/(No. of emplaced ordnance in the test site).

Discrimination Stage False Positive (fp^{disc}): An anomaly location that is within R_{halo} of an emplaced clutter item.

Discrimination Stage Probability of False Positive (P_{fp}^{disc}): P_{fp}^{disc} = (No. of discrimination stage false positives)/(No. of emplaced clutter items).

Discrimination Stage Background Alarm (ba^{disc}): An anomaly in a blind grid cell that contains neither emplaced ordnance nor an emplaced clutter item. An anomaly location in the open field or scenarios that is outside R_{halo} of any emplaced ordnance or emplaced clutter item.

Discrimination Stage Probability of Background Alarm (P_{ba}^{disc}): P_{ba}^{disc} = (No. of discrimination-stage background alarms)/(No. of empty grid locations).

Discrimination Stage Background Alarm Rate (BAR^{disc}): BAR^{disc} = (No. of discrimination-stage background alarms)/(arbitrary constant).

Note that the quantities P_d^{disc}, P_{fp}^{disc}, P_{ba}^{disc}, and BAR^{disc} are functions of t^{disc}, the threshold applied to the discrimination-stage signal strength. These quantities can therefore be written as $P_d^{disc}(t^{disc})$, $P_{fp}^{disc}(t^{disc})$, $P_{ba}^{disc}(t^{disc})$, and $BAR^{disc}(t^{disc})$.

RECEIVER-OPERATING CHARACERISTIC (ROC) CURVES

ROC curves at both the response and discrimination stages can be constructed based on the above definitions. The ROC curves plot the relationship between P_d versus P_{fp} and P_d versus BAR or P_{ba} as the threshold applied to the signal strength is varied from its minimum (t_{min}) to its maximum (t_{max}) value.[1] Figure A-1 shows how P_d versus P_{fp} and P_d versus BAR are combined into ROC curves. Note that the "res" and "disc" superscripts have been suppressed from all the variables for clarity.

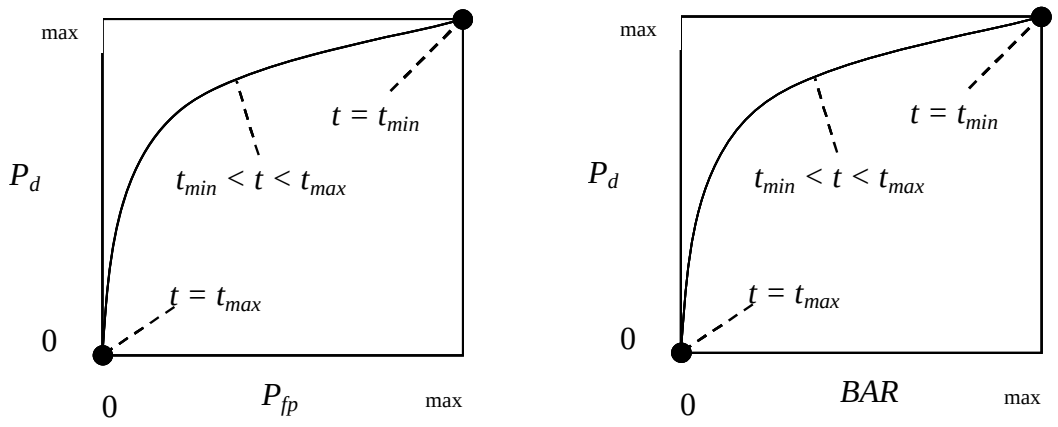

Figure A-1. ROC curves for open field testing. Each curve applies to both the response and discrimination stages.

[1]Strictly speaking, ROC curves plot the P_d versus P_{ba} over a pre-determined and fixed number of detection opportunities (some of the opportunities are located over ordnance and others are located over clutter or blank spots). In an open field scenario, each system suppresses its signal strength reports until some bare-minimum signal response is received by the system. Consequently, the open field ROC curves do not have information from low signal-output locations, and, furthermore, different contractors report their signals over a different set of locations on the ground. These ROC curves are thus not true to the strict definition of ROC curves as defined in textbooks on detection theory. Note, however, that the ROC curves obtained in the Blind Grid test sites are true ROC curves.

METRICS TO CHARACTERIZE THE DISCRIMINATION STAGE

The demonstrator is also scored on efficiency and rejection ratio, which measure the effectiveness of the discrimination stage processing. The goal of discrimination is to retain the greatest number of ordnance detections from the anomaly list, while rejecting the maximum number of anomalies arising from nonordnance items. The efficiency measures the amount of detected ordnance retained by the discrimination, while the rejection ratio measures the fraction of false alarms rejected. Both measures are defined relative to the entire response list, i.e., the maximum ordnance detectable by the sensor and its accompanying false positive rate or background alarm rate.

Efficiency (E): $E = P_d^{disc}(t^{disc})/P_d^{res}(t_{min}^{res})$; Measures (at a threshold of interest), the degree to which the maximum theoretical detection performance of the sensor system (as determined by the response stage tmin) is preserved after application of discrimination techniques. Efficiency is a number between 0 and 1. An efficiency of 1 implies that all of the ordnance initially detected in the response stage was retained at the specified threshold in the discrimination stage, t^{disc}.

False Positive Rejection Rate (R_{fp}): $R_{fp} = 1 - [P_{fp}^{disc}(t^{disc})/P_{fp}^{res}(t_{min}^{res})]$; Measures (at a threshold of interest), the degree to which the sensor system's false positive performance is improved over the maximum false positive performance (as determined by the response stage tmin). The rejection rate is a number between 0 and 1. A rejection rate of 1 implies that all emplaced clutter initially detected in the response stage were correctly rejected at the specified threshold in the discrimination stage.

Background Alarm Rejection Rate (R_{ba}):

Blind Grid: $R_{ba} = 1 - [P_{ba}^{disc}(t^{disc})/P_{ba}^{res}(t_{min}^{res})]$.
Open Field: $R_{ba} = 1 - [BAR^{disc}(t^{disc})/BAR^{res}(t_{min}^{res})])$.

Measures the degree to which the discrimination stage correctly rejects background alarms initially detected in the response stage. The rejection rate is a number between 0 and 1. A rejection rate of 1 implies that all background alarms initially detected in the response stage were rejected at the specified threshold in the discrimination stage.

CHI-SQUARE COMPARISON EXPLANATION:

The Chi-square test for differences in probabilities (or 2 x 2 contingency table) is used to analyze two samples drawn from two different populations to see if both populations have the same or different proportions of elements in a certain category. More specifically, two random samples are drawn, one from each population, to test the null hypothesis that the probability of event A (some specified event) is the same for both populations (ref 3).

A 2 x 2 contingency table is used in the Standardized UXO Technology Demonstration Site Program to determine if there is reason to believe that the proportion of ordnance correctly detected/discriminated by demonstrator X's system is significantly degraded by the more challenging terrain feature introduced. The test statistic of the 2 x 2 contingency table is the

Chi-square distribution with one degree of freedom. Since an association between the more challenging terrain feature and relatively degraded performance is sought, a one-sided test is performed. A significance level of 0.05 is chosen which sets a critical decision limit of 2.71 from the Chi-square distribution with one degree of freedom. It is a critical decision limit because if the test statistic calculated from the data exceeds this value, the two proportions tested will be considered significantly different. If the test statistic calculated from the data is less than this value, the two proportions tested will be considered not significantly different.

An exception must be applied when either a 0 or 100 percent success rate occurs in the sample data. The Chi-square test cannot be used in these instances. Instead, Fischer's test is used and the critical decision limit for one-sided tests is the chosen significance level, which in this case is 0.05. With Fischer's test, if the test statistic is less than the critical value, the proportions are considered to be significantly different.

Standardized UXO Technology Demonstration Site examples, where blind grid results are compared to those from the open field and open field results are compared to those from one of the scenarios, follow. It should be noted that a significant result does not prove a cause and effect relationship exists between the two populations of interest; however, it does serve as a tool to indicate that one data set has experienced a degradation in system performance at a large enough level than can be accounted for merely by chance or random variation. Note also that a result that is not significant indicates that there is not enough evidence to declare that anything more than chance or random variation within the same population is at work between the two data sets being compared.

Demonstrator X achieves the following overall results after surveying each of the three progressively more difficult areas using the same system (results indicate the number of ordnance detected divided by the number of ordnance emplaced):

	Blind Grid	Open Field	Moguls
P_d^{res}	100/100 = 1.0	8/10 = .80	20/33 = .61
P_d^{disc}	80/100 = 0.80	6/10 = .60	8/33 = .24

P_d^{res}: BLIND GRID versus OPEN FIELD. Using the example data above to compare probabilities of detection in the response stage, all 100 ordnance out of 100 emplaced ordnance items were detected in the blind grid while 8 ordnance out of 10 emplaced were detected in the open field. Fischer's test must be used since a 100 percent success rate occurs in the data. Fischer's test uses the four input values to calculate a test statistic of 0.0075 that is compared against the critical value of 0.05. Since the test statistic is less than the critical value, the smaller response stage detection rate (0.80) is considered to be significantly less at the 0.05 level of significance. While a significant result does not prove a cause and effect relationship exists between the change in survey area and degradation in performance, it does indicate that the detection ability of demonstrator X's system seems to have been degraded in the open field relative to results from the blind grid using the same system.

P_d^{disc}: BLIND GRID versus OPEN FIELD. Using the example data above to compare probabilities of detection in the discrimination stage, 80 out of 100 emplaced ordnance items were correctly discriminated as ordnance in blind grid testing while 6 ordnance out of 10 emplaced were correctly discriminated as such in open field-testing. Those four values are used to calculate a test statistic of 1.12. Since the test statistic is less than the critical value of 2.71, the two discrimination stage detection rates are considered to be not significantly different at the 0.05 level of significance.

P_d^{res}: OPEN FIELD versus MOGULS. Using the example data above to compare probabilities of detection in the response stage, 8 out of 10 and 20 out of 33 are used to calculate a test statistic of 0.56. Since the test statistic is less than the critical value of 2.71, the two response stage detection rates are considered to be not significantly different at the 0.05 level of significance.

P_d^{disc}: OPEN FIELD versus MOGULS. Using the example data above to compare probabilities of detection in the discrimination stage, 6 out of 10 and 8 out of 33 are used to calculate a test statistic of 2.98. Since the test statistic is greater than the critical value of 2.71, the smaller discrimination stage detection rate is considered to be significantly less at the 0.05 level of significance. While a significant result does not prove a cause and effect relationship exists between the change in survey area and degradation in performance, it does indicate that the ability of demonstrator X to correctly discriminate seems to have been degraded by the mogul terrain relative to results from the flat open field using the same system.

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APPENDIX B. DAILY WEATHER LOGS

TABLE B-1. WEATHER LOG

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/14/2004 00:00:00	66.1	66.9	64.6	99.5	0
09/14/2004 01:00:00	65.5	66.2	64.5	99.9	0
09/14/2004 02:00:00	65.2	66.2	64.3	100	0
09/14/2004 03:00:00	65.5	66.6	63.9	99	0
09/14/2004 04:00:00	65.6	67.3	64.6	97.8	0
09/14/2004 05:00:00	67.3	68.1	66.4	96	0
09/14/2004 06:00:00	67.3	68.2	66.4	98.2	0
09/14/2004 07:00:00	68.5	69.3	67.7	99.4	0
09/14/2004 08:00:00	69.9	70.8	69	97.5	0
09/14/2004 09:00:00	71.2	72.9	70.1	90.5	0
09/14/2004 10:00:00	73.3	73.9	72.5	83.3	0
09/14/2004 11:00:00	75.3	76.3	73.7	81.4	0
09/14/2004 12:00:00	76.3	77.5	75.1	78.85	0
09/14/2004 13:00:00	77.5	78.5	76.6	74.85	0
09/14/2004 14:00:00	76.7	78.1	74	74.82	0
09/14/2004 15:00:00	74	74.6	73.4	83.4	0
09/14/2004 16:00:00	72.6	73.8	72	84.6	0
09/14/2004 17:00:00	72.2	73.3	71.5	83.6	0
09/14/2004 18:00:00	71.5	72	71.1	84.7	0
09/14/2004 19:00:00	70.7	71.5	70	83.4	0
09/14/2004 20:00:00	69.5	70.4	68.9	83.3	0
09/14/2004 21:00:00	68.9	69.3	68.6	81.4	0
09/14/2004 22:00:00	68.3	68.9	67.7	81.1	0
09/14/2004 23:00:00	67.6	68.2	67.1	80.7	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/15/2004 00:00:00	67.1	67.6	66.2	80.5	0
09/15/2004 01:00:00	65.8	66.7	64.6	84.2	0
09/15/2004 02:00:00	65.3	65.7	64.9	85.4	0
09/15/2004 03:00:00	64.7	65.8	63.9	87.1	0
09/15/2004 04:00:00	63.9	64.4	63.3	88.9	0
09/15/2004 05:00:00	63.9	64.3	63.4	88	0
09/15/2004 06:00:00	64.2	64.6	63.8	88.3	0
09/15/2004 07:00:00	64.6	65	64.2	90.3	0
09/15/2004 08:00:00	64.7	65.1	64.3	94.1	0.01
09/15/2004 09:00:00	65.2	66.3	64.5	94.8	0
09/15/2004 10:00:00	67	68	65.9	93.8	0
09/15/2004 11:00:00	67.8	68.2	67.2	93.5	0
09/15/2004 12:00:00	68.7	69.6	67.7	93.6	0
09/15/2004 13:00:00	70.1	70.7	69.3	91.7	0.01
09/15/2004 14:00:00	70.3	70.8	69.9	91.5	0
09/15/2004 15:00:00	70.9	72	70.2	90.8	0
09/15/2004 16:00:00	70.2	71.9	69	94.1	0
09/15/2004 17:00:00	69.1	69.9	68.3	98.2	0.02
09/15/2004 18:00:00	68.5	68.9	68.2	99	0
09/15/2004 19:00:00	68	68.4	67.5	99.2	0
09/15/2004 20:00:00	67.6	68	67.2	99.4	0.01
09/15/2004 21:00:00	68	68.6	67.5	99.9	0
09/15/2004 22:00:00	68.4	68.8	68	99.7	0
09/15/2004 23:00:00	68.3	68.7	68.1	99.3	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/16/2004 00:00:00	68.3	68.7	68.1	99.3	0
09/16/2004 01:00:00	68.5	68.8	68.2	99.4	0
09/16/2004 02:00:00	68.4	68.8	68	99.6	0
09/16/2004 03:00:00	68.3	68.6	68	99.9	0
09/16/2004 04:00:00	68.3	68.7	68	99.9	0
09/16/2004 05:00:00	68.2	68.6	67.8	99.9	0
09/16/2004 06:00:00	68.2	68.4	67.8	99.9	0
09/16/2004 07:00:00	68.4	69	68	100	0
09/16/2004 08:00:00	69.4	70.1	68.6	99.1	0
09/16/2004 09:00:00	70.6	71.8	69.6	95.6	0
09/16/2004 10:00:00	72.5	73.3	71.3	90	0
09/16/2004 11:00:00	74.3	76.9	72.8	85	0
09/16/2004 12:00:00	76.1	77	75.2	75.68	0
09/16/2004 13:00:00	77.8	78.9	76.8	73.03	0
09/16/2004 14:00:00	78.1	79.4	77.2	73.58	0
09/16/2004 15:00:00	78.7	79.4	78.1	71.51	0
09/16/2004 16:00:00	78.9	79.9	78.1	71.52	0
09/16/2004 17:00:00	77.7	78.7	76.4	76.36	0
09/16/2004 18:00:00	75.3	76.6	72.7	82.8	0
09/16/2004 19:00:00	71.1	72.8	69.9	94.5	0
09/16/2004 20:00:00	69.8	70.7	69.2	97.8	0
09/16/2004 21:00:00	69.3	69.6	68.8	99.1	0
09/16/2004 22:00:00	69.2	69.8	68.7	99.7	0
09/16/2004 23:00:00	69.5	69.9	69	99.9	0
Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/17/2004 00:00:00	69.6	70.2	69	100	0
09/17/2004 01:00:00	69.6	70	69	100	0

09/17/2004 02:00:00	69.4	70	68.8	100	0
09/17/2004 03:00:00	69.6	70.1	68.9	100	0
09/17/2004 04:00:00	69.6	70	69	100	0
09/17/2004 05:00:00	69.6	70	69	100	0
09/17/2004 06:00:00	69.4	70	68.9	100	0
09/17/2004 07:00:00	69.7	71	68.6	100	0
09/17/2004 08:00:00	71.3	72.3	70.5	100	0
09/17/2004 09:00:00	72.5	73.5	71.8	98.8	0
09/17/2004 10:00:00	74.2	74.9	73	94.1	0
09/17/2004 11:00:00	74.7	75.8	73.9	92.6	0
09/17/2004 12:00:00	77	78.5	75.5	86.5	0
09/17/2004 13:00:00	77.5	78.5	76.6	86.5	0.01
09/17/2004 14:00:00	77.6	80.1	75.8	94.4	0.03
09/17/2004 15:00:00	79.2	80	78.4	90.1	0
09/17/2004 16:00:00	78.9	79.5	78.1	91	0
09/17/2004 17:00:00	78.7	79.2	78.1	91.3	0
09/17/2004 18:00:00	77.6	78.5	77	92	0
09/17/2004 19:00:00	76.9	77.5	76.2	93.8	0
09/17/2004 20:00:00	76.4	76.8	75.8	95.1	0.06
09/17/2004 21:00:00	76.2	76.9	75.7	96.2	0
09/17/2004 22:00:00	77.4	78.1	76.7	92.4	0
09/17/2004 23:00:00	78	78.5	77.5	90.6	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/18/2004 00:00:00	78	78.7	76.9	91.2	0.03
09/18/2004 01:00:00	76.8	77.3	76.4	96	0.07
09/18/2004 02:00:00	76.3	76.8	75.7	97.1	0.44
09/18/2004 03:00:00	75.7	76.2	75.2	94.6	0
09/18/2004 04:00:00	75.1	75.8	74.4	94.5	0
09/18/2004 05:00:00	74.4	74.9	73.9	96.6	0.02
09/18/2004 06:00:00	73.9	74.4	73.3	98.7	0.21
09/18/2004 07:00:00	68.3	73.8	66	98.5	0.14
09/18/2004 08:00:00	65.6	66.5	64.7	97.3	0.13
09/18/2004 09:00:00	65	65.6	64.5	96.5	0.1
09/18/2004 10:00:00	65.4	65.8	65	93.8	0.01
09/18/2004 11:00:00	65	65.8	63	93.7	0.04
09/18/2004 12:00:00	62.8	63.3	62.4	94	0.04
09/18/2004 13:00:00	65.1	66.8	62.5	88.1	0
09/18/2004 14:00:00	66.5	67.3	65.7	80.1	0
09/18/2004 15:00:00	67	67.4	66.7	77.25	0
09/18/2004 16:00:00	66.4	67.1	65.8	76.72	0
09/18/2004 17:00:00	66.7	67.2	66.3	74.23	0
09/18/2004 18:00:00	66.1	66.8	65.5	73.63	0
09/18/2004 19:00:00	65.5	66.1	65.1	72.58	0
09/18/2004 20:00:00	64.6	65.6	63.4	71.37	0
09/18/2004 21:00:00	62.7	63.7	62	74.55	0
09/18/2004 22:00:00	61.8	62.4	60.9	71.94	0
09/18/2004 23:00:00	60.4	61.4	59.5	70.76	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/19/2004 00:00:00	58.9	59.7	58.2	69.08	0
09/19/2004 01:00:00	57.8	58.4	57.2	64.66	0
09/19/2004 02:00:00	56.8	57.6	56.2	63.18	0
09/19/2004 03:00:00	55.5	56.6	54.4	65	0
09/19/2004 04:00:00	53.8	55	52	69.89	0
09/19/2004 05:00:00	52.1	52.7	51.2	74.7	0
09/19/2004 06:00:00	51.2	51.7	50.6	76.51	0
09/19/2004 07:00:00	53	54.5	51.2	72.93	0
09/19/2004 08:00:00	55.7	56.7	54.3	65.69	0
09/19/2004 09:00:00	57.2	58	56	59.04	0
09/19/2004 10:00:00	59.1	60.3	57.5	56.89	0
09/19/2004 11:00:00	61.3	62.8	60	53	0
09/19/2004 12:00:00	64	66.1	62.4	48.71	0
09/19/2004 13:00:00	66.4	67.7	64.9	45.91	0
09/19/2004 14:00:00	68.1	69.5	67	43.48	0
09/19/2004 15:00:00	69.4	70.2	68.4	40.84	0
09/19/2004 16:00:00	70	70.4	69.3	38.25	0
09/19/2004 17:00:00	70	70.6	69.1	39.22	0
09/19/2004 18:00:00	67.4	70	63.9	48.83	0
09/19/2004 19:00:00	61.1	64.4	58.7	67.16	0
09/19/2004 20:00:00	57.5	59	55.2	78.96	0
09/19/2004 21:00:00	58.7	59.8	58	64.06	0
09/19/2004 22:00:00	59.8	60.6	58.9	59.12	0
09/19/2004 23:00:00	58.2	59.4	56.9	64.37	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/20/2004 00:00:00	56.4	57.6	55.3	70	0
09/20/2004 01:00:00	55.1	55.8	54.6	73.74	0
09/20/2004 02:00:00	54.1	54.7	53.5	76.62	0
09/20/2004 03:00:00	53.1	54	52.4	79.66	0
09/20/2004 04:00:00	51.3	52.7	50.1	85.5	0
09/20/2004 05:00:00	49.3	50.6	47.9	91.5	0
09/20/2004 06:00:00	48.8	49.4	47.9	92.8	0
09/20/2004 07:00:00	51.3	53.7	49.1	86.1	0
09/20/2004 08:00:00	55.9	58.2	53.3	75.06	0
09/20/2004 09:00:00	60.4	61.7	58	63.06	0
09/20/2004 10:00:00	61.7	62.8	60.9	59.31	0
09/20/2004 11:00:00	63.6	64.8	61.8	55.41	0
09/20/2004 12:00:00	65.3	66.3	64.2	51.91	0
09/20/2004 13:00:00	67.1	68.4	65.9	50.18	0
09/20/2004 14:00:00	69.8	71.5	68.3	46.38	0
09/20/2004 15:00:00	71.3	72.5	70.4	41.46	0
09/20/2004 16:00:00	71.1	73	69.5	49.22	0
09/20/2004 17:00:00	69.2	70.1	67.6	56.53	0
09/20/2004 18:00:00	66.3	68	63.3	63.38	0
09/20/2004 19:00:00	60.7	63.6	57.5	80	0
09/20/2004 20:00:00	56.3	57.7	54.8	92.8	0
09/20/2004 21:00:00	54.8	55.8	53.6	96.9	0
09/20/2004 22:00:00	53.8	54.4	53	98.9	0
09/20/2004 23:00:00	53.3	54	52	99.2	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/21/2004 00:00:00	52.1	52.8	51.4	99.8	0
09/21/2004 01:00:00	51.4	52.2	50.6	99.9	0
09/21/2004 02:00:00	51.2	51.7	50.6	100	0
09/21/2004 03:00:00	50.8	51.4	49.8	100	0
09/21/2004 04:00:00	49.8	50.4	49.4	100	0
09/21/2004 05:00:00	49.9	50.6	49.1	100	0
09/21/2004 06:00:00	49.7	50.3	49.1	100	0
09/21/2004 07:00:00	50.1	52.5	49.2	100	0
09/21/2004 08:00:00	56	60.5	52	95.9	0
09/21/2004 09:00:00	65	69.1	60.5	77.34	0
09/21/2004 10:00:00	72.3	75.6	68.7	58	0
09/21/2004 11:00:00	76.4	78.2	74.9	46.52	0
09/21/2004 12:00:00	78.9	80.6	77.3	40.34	0
09/21/2004 13:00:00	81.4	82.5	80.1	28.04	0
09/21/2004 14:00:00	82.2	83.3	80.7	29.15	0
09/21/2004 15:00:00	83.2	84.1	82.2	31.89	0
09/21/2004 16:00:00	80.2	83.9	77.2	40.47	0
09/21/2004 17:00:00	78.6	80.2	75.3	50.58	0
09/21/2004 18:00:00	71.5	75.4	68.5	73.81	0
09/21/2004 19:00:00	66.9	68.8	64.1	88.6	0
09/21/2004 20:00:00	63.8	64.9	63	95.4	0
09/21/2004 21:00:00	62	63.1	60.8	97.4	0
09/21/2004 22:00:00	59.9	61.3	58.7	98.2	0
09/21/2004 23:00:00	58.7	59.4	58.1	99.4	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/22/2004 00:00:00	58.2	58.8	57.5	99.8	0
09/22/2004 01:00:00	57	57.8	56.5	99.9	0
09/22/2004 02:00:00	56.3	57.1	55.3	100	0
09/22/2004 03:00:00	55.3	56	54.6	100	0
09/22/2004 04:00:00	54.3	55.2	53.5	100	0
09/22/2004 05:00:00	53.9	54.7	52.7	100	0
09/22/2004 06:00:00	53.5	54.9	52.3	100	0
09/22/2004 07:00:00	58	62.9	53.2	92.7	0
09/22/2004 08:00:00	66.8	69.4	62.8	72.31	0
09/22/2004 09:00:00	71.7	74.1	69.2	57.29	0
09/22/2004 10:00:00	75.9	77.9	73.8	46.35	0
09/22/2004 11:00:00	79.1	80.9	77.6	42.67	0
09/22/2004 12:00:00	81.4	82.6	80.2	39.87	0
09/22/2004 13:00:00	82.6	83.4	81.5	38.06	0
09/22/2004 14:00:00	83.5	84.3	82.5	37.25	0
09/22/2004 15:00:00	84.1	84.9	83.3	36.22	0
09/22/2004 16:00:00	84	84.9	83.6	35.71	0
09/22/2004 17:00:00	83.2	84.5	81.6	38.55	0
09/22/2004 18:00:00	79	82.1	75.8	47.4	0
09/22/2004 19:00:00	70.6	76.2	67.3	69.49	0
09/22/2004 20:00:00	65.9	68.8	63.9	84.9	0
09/22/2004 21:00:00	63.4	64.4	61.8	91.4	0
09/22/2004 22:00:00	62.6	66.7	61	91.4	0
09/22/2004 23:00:00	61.4	66.2	60.5	94.3	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/23/2004 00:00:00	67.3	68.4	66	74.21	0
09/23/2004 01:00:00	68.3	70	66.1	70.59	0
09/23/2004 02:00:00	70.6	71.1	69.5	63.77	0
09/23/2004 03:00:00	69.8	70.6	69.1	64.93	0
09/23/2004 04:00:00	68.9	70	68.2	66.39	0
09/23/2004 05:00:00	68.7	69.2	68.2	65.71	0
09/23/2004 06:00:00	68.1	69	66.7	65.31	0
09/23/2004 07:00:00	68.4	70.3	66.8	65.38	0
09/23/2004 08:00:00	71.9	74	70	60.85	0
09/23/2004 09:00:00	75.6	77.2	73.6	56.84	0
09/23/2004 10:00:00	78.3	79.5	76.6	56.41	0
09/23/2004 11:00:00	81.1	83.3	79.1	54.83	0
09/23/2004 12:00:00	83.9	84.9	83	52.22	0
09/23/2004 13:00:00	85.1	85.7	84.3	51.32	0
09/23/2004 14:00:00	85.1	85.7	84.5	50.77	0
09/23/2004 15:00:00	84.4	85.4	83.3	52.33	0
09/23/2004 16:00:00	83.8	84.9	82.5	54.72	0
09/23/2004 17:00:00	81.5	83	80.3	61.3	0
09/23/2004 18:00:00	78.4	80.7	75.1	69.64	0
09/23/2004 19:00:00	73	75.2	71.3	86	0
09/23/2004 20:00:00	70	71.5	68.7	91.9	0
09/23/2004 21:00:00	70.8	71.9	69	81.9	0
09/23/2004 22:00:00	67.1	69.3	65.1	91.7	0
09/23/2004 23:00:00	64.8	65.5	64.3	97	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/24/2004 00:00:00	63.5	64.4	62.7	98.3	0
09/24/2004 01:00:00	62.5	63.4	61.5	99.6	0
09/24/2004 02:00:00	61.7	62.2	61.1	100	0
09/24/2004 03:00:00	60.9	61.5	60.2	100	0
09/24/2004 04:00:00	60.3	61.1	58.9	100	0
09/24/2004 05:00:00	60	60.9	58.9	100	0
09/24/2004 06:00:00	59.2	60.2	58.2	100	0
09/24/2004 07:00:00	59.4	61.3	58.2	100	0
09/24/2004 08:00:00	63.3	66.1	60.8	99.9	0
09/24/2004 09:00:00	69.4	71	66	89.6	0
09/24/2004 10:00:00	72.8	74.9	70.7	80.8	0
09/24/2004 11:00:00	75.4	76.9	74	72.76	0
09/24/2004 12:00:00	76.7	77.6	75.6	66.19	0
09/24/2004 13:00:00	77.5	78.4	76.2	65.18	0
09/24/2004 14:00:00	77.6	78.8	77	63.76	0
09/24/2004 15:00:00	76.9	78	76	66.03	0
09/24/2004 16:00:00	77.7	79.8	75.6	65.21	0
09/24/2004 17:00:00	77.8	78.9	76.8	63	0
09/24/2004 18:00:00	74.5	77.1	70.3	73.49	0
09/24/2004 19:00:00	68.5	70.7	67.2	90.7	0
09/24/2004 20:00:00	68.3	68.9	67.5	85.8	0
09/24/2004 21:00:00	66.4	68	64.4	84	0
09/24/2004 22:00:00	63.6	64.9	62.1	90.9	0
09/24/2004 23:00:00	60.8	62.6	59.5	96.4	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/25/2004 00:00:00	58.7	60	57.5	99.4	0
09/25/2004 01:00:00	58	58.9	57.3	100	0
09/25/2004 02:00:00	57.2	57.7	56.8	100	0
09/25/2004 03:00:00	56.4	57.5	55.6	100	0
09/25/2004 04:00:00	56.3	56.8	55.8	100	0
09/25/2004 05:00:00	55.5	56.3	55	100	0
09/25/2004 06:00:00	55.1	55.8	54.4	100	0
09/25/2004 07:00:00	56.2	58.3	54.1	100	0
09/25/2004 08:00:00	60.6	62.6	58.1	100	0
09/25/2004 09:00:00	65	68	62.3	96.9	0
09/25/2004 10:00:00	70.3	72.8	67.7	82.9	0
09/25/2004 11:00:00	72.9	74.6	71.4	74.6	0
09/25/2004 12:00:00	74.8	76.2	73	68.89	0
09/25/2004 13:00:00	74.5	76.2	73.7	70.77	0
09/25/2004 14:00:00	76.4	78.4	75.3	58	0
09/25/2004 15:00:00	76.9	78.1	75.8	49.15	0
09/25/2004 16:00:00	75.5	77.1	74.5	59.94	0
09/25/2004 17:00:00	74.2	75	73.5	65.52	0
09/25/2004 18:00:00	69.9	73.7	67.6	73.48	0
09/25/2004 19:00:00	66.1	67.9	64.9	83.6	0
09/25/2004 20:00:00	63.7	64.9	63.2	90.2	0
09/25/2004 21:00:00	62.3	63.8	61.3	94.5	0
09/25/2004 22:00:00	60.9	61.5	60.1	97.4	0
09/25/2004 23:00:00	59.6	60.6	58.8	99.2	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/26/2004 00:00:00	58.8	59.6	57.9	100	0
09/26/2004 01:00:00	58	58.7	57.5	100	0
09/26/2004 02:00:00	57.4	58.2	56.9	100	0
09/26/2004 03:00:00	56.9	57.7	56	100	0
09/26/2004 04:00:00	56.5	57.2	55.8	100	0
09/26/2004 05:00:00	57.4	58.4	56.6	100	0
09/26/2004 06:00:00	58.9	59.7	58.2	100	0
09/26/2004 07:00:00	60.3	61.5	59.5	100	0
09/26/2004 08:00:00	63.5	65.8	61.2	96.9	0
09/26/2004 09:00:00	67.2	69.2	65.5	88.9	0
09/26/2004 10:00:00	69.8	70.6	68.8	80.2	0
09/26/2004 11:00:00	71.2	72.3	70.1	77.42	0
09/26/2004 12:00:00	71.4	72.3	70.9	77.65	0
09/26/2004 13:00:00	71.9	73.3	71.3	76.8	0
09/26/2004 14:00:00	73.2	74.3	72.5	72.78	0
09/26/2004 15:00:00	73.6	74.4	72.5	71.14	0
09/26/2004 16:00:00	73.8	74.5	73.1	67.94	0
09/26/2004 17:00:00	72.6	73.8	70.6	72.27	0
09/26/2004 18:00:00	68.8	70.9	67	85.3	0
09/26/2004 19:00:00	65.4	67.2	63.8	94.5	0
09/26/2004 20:00:00	63.1	63.9	62.4	98.3	0
09/26/2004 21:00:00	62.5	63.2	61.9	99.7	0
09/26/2004 22:00:00	61.6	62.4	60.8	100	0
09/26/2004 23:00:00	60.8	61.3	60.2	100	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/27/2004 00:00:00	60.5	60.9	60	100	0
09/27/2004 01:00:00	60.7	61.3	60	100	0
09/27/2004 02:00:00	60.7	61.3	60.1	100	0
09/27/2004 03:00:00	60.4	61.4	59.7	100	0
09/27/2004 04:00:00	59.8	61.1	58.9	100	0
09/27/2004 05:00:00	58.7	59.4	57.9	100	0
09/27/2004 06:00:00	58.7	59.7	57.1	100	0
09/27/2004 07:00:00	57.8	59.1	57.1	100	0
09/27/2004 08:00:00	62	65.4	58.9	98.4	0
09/27/2004 09:00:00	67	69.1	65.1	85.6	0
09/27/2004 10:00:00	70.2	71.9	68.5	79.24	0
09/27/2004 11:00:00	73.2	74.5	71.7	77.07	0
09/27/2004 12:00:00	75.4	76.7	74	73.61	0
09/27/2004 13:00:00	76.4	77.1	75.9	70.85	0
09/27/2004 14:00:00	77	77.8	76.2	67.99	0
09/27/2004 15:00:00	76.3	77.6	75.1	70.66	0
09/27/2004 16:00:00	74.6	75.3	73.7	75.07	0
09/27/2004 17:00:00	73.1	74.2	72.1	72.72	0
09/27/2004 18:00:00	71.6	72.5	70.8	79.72	0
09/27/2004 19:00:00	70.7	71.4	70.1	82.2	0
09/27/2004 20:00:00	69.8	70.5	69	84.5	0
09/27/2004 21:00:00	69.4	69.9	68.7	88.6	0
09/27/2004 22:00:00	69	69.4	68.4	93.2	0
09/27/2004 23:00:00	69.2	69.6	68.8	94.7	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/28/2004 01:00:00	68.9	69.6	68.4	99	0
09/28/2004 02:00:00	69.2	69.6	68.9	99.7	0.01
09/28/2004 03:00:00	69.4	69.6	69	100	0
09/28/2004 04:00:00	69.5	69.9	69.2	100	0
09/28/2004 05:00:00	69.9	70.1	69.5	100	0.03
09/28/2004 06:00:00	70.1	70.5	69.6	100	0
09/28/2004 07:00:00	70.2	70.7	69.9	100	0
09/28/2004 08:00:00	71.5	72.2	70.5	100	0.01
09/28/2004 09:00:00	72.7	73.6	71.8	100	0
09/28/2004 10:00:00	74.1	74.9	73.1	100	0
09/28/2004 11:00:00	75.2	76	74.4	99.2	0
09/28/2004 12:00:00	75.4	75.8	74.9	98.2	0
09/28/2004 13:00:00	75.6	76.6	74.9	98.8	0.04
09/28/2004 14:00:00	75.1	76	74.2	98.8	0.11
09/28/2004 15:00:00	74.2	75.1	73.3	98.8	0.07
09/28/2004 16:00:00	73.2	74	72.7	99.8	0.7
09/28/2004 17:00:00	73	73.5	71.9	99.7	0.4
09/28/2004 18:00:00	70.5	72.2	69.2	97.9	0.47
09/28/2004 19:00:00	68.4	69.4	67.7	97.6	0.5
09/28/2004 20:00:00	67.9	68.3	67.5	96.1	0.2
09/28/2004 21:00:00	68.1	68.8	67.6	94.3	0.1
09/28/2004 22:00:00	68.2	68.6	67.7	93.4	0.05
09/28/2004 23:00:00	68.3	69	67.6	92	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/29/2004 00:00:00	67.9	68.6	67.5	93	0.01
09/29/2004 01:00:00	67.5	68	67	92.3	0
09/29/2004 02:00:00	67.2	67.6	66.8	89.5	0
09/29/2004 03:00:00	67	67.4	66.3	87.1	0
09/29/2004 04:00:00	66.3	66.7	65.8	86.8	0
09/29/2004 05:00:00	65.7	66.4	65.2	86.3	0
09/29/2004 06:00:00	65.6	66.1	65.2	86.3	0
09/29/2004 07:00:00	65.8	66.4	65.4	87	0
09/29/2004 08:00:00	67.1	68.3	66.1	83.3	0
09/29/2004 09:00:00	68.5	69.7	67.7	79.93	0
09/29/2004 10:00:00	69.6	70.4	68.6	77.27	0
09/29/2004 11:00:00	70	71.1	69	75.5	0
09/29/2004 12:00:00	70.2	70.9	69.6	75.25	0
09/29/2004 13:00:00	70.5	71.7	69.6	74.55	0
09/29/2004 14:00:00	71.7	72.6	70.7	71.94	0
09/29/2004 15:00:00	70.8	71.8	70.1	74.31	0
09/29/2004 16:00:00	69.9	70.6	68.7	77.25	0
09/29/2004 17:00:00	69	69.6	68.5	81.5	0
09/29/2004 18:00:00	67.7	68.8	66.8	85.2	0
09/29/2004 19:00:00	66.7	67.4	65.8	89.2	0
09/29/2004 20:00:00	65.7	66.3	65	92	0
09/29/2004 21:00:00	64.8	65.5	64.3	92.5	0
09/29/2004 22:00:00	63.8	65	62.4	93.7	0
09/29/2004 23:00:00	62.7	63.2	62.1	97.9	0

Date & Time	Average Temp (°F)	Maximum Temp (°F)	Minimum Temp (°F)	Relative Humidity (%)	Total Precip (in)
09/30/2004 00:00:00	63.5	64	62.8	98.5	0
09/30/2004 01:00:00	64.2	64.6	63.7	96.6	0
09/30/2004 02:00:00	64.2	64.5	63.9	95.1	0
09/30/2004 03:00:00	63.8	64.2	63.4	97.2	0
09/30/2004 04:00:00	63.8	64.2	63.3	96.7	0
09/30/2004 05:00:00	63.8	64.2	63.4	96.7	0
09/30/2004 06:00:00	63.6	63.9	63.2	97.6	0
09/30/2004 07:00:00	63.9	64.4	63.4	98	0
09/30/2004 08:00:00	64.2	64.5	63.9	98	0
09/30/2004 09:00:00	64.5	64.9	64	98.3	0
09/30/2004 10:00:00	64.8	65.7	64.3	98.8	0.02
09/30/2004 11:00:00	66.8	68.5	65.4	96.5	0
09/30/2004 12:00:00	70.1	72.2	68	85.4	0
09/30/2004 13:00:00	71.8	73.4	69.9	80	0
09/30/2004 14:00:00	73.5	75.1	72.5	71.11	0
09/30/2004 15:00:00	72.9	74	71.3	76.16	0
09/30/2004 16:00:00	72.2	73.9	70.7	75.27	0
09/30/2004 17:00:00	73.9	75.5	72.6	60.54	0
09/30/2004 18:00:00	69.1	72.7	65.4	72.7	0
09/30/2004 19:00:00	64.3	65.7	62.7	81	0
09/30/2004 20:00:00	61.2	62.9	60	83.5	0
09/30/2004 21:00:00	59.4	61.1	56.9	82.5	0
09/30/2004 22:00:00	56.4	58.4	55.1	90.8	0
09/30/2004 23:00:00	55	58.2	53.9	92.1	0

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APPENDIX C. SOIL MOISTURE

Demonstrator: Parsons
Date: 9/14/04
Times: 1020 hours, 1315 hours

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Wooded Area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open Area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Calibration Lanes	0 to 6	1.3	
	6 to 12	14.3	
	12 to 24	24.4	
	24 to 36	30.9	
	36 to 48	37.1	
Blind Grid/Moguls	0 to 6		3.3
	6 to 12		0.5
	12 to 24		23.9
	24 to 36		35.8
	36 to 48		39.0

Demonstrator: Parsons
Date: 9/15/04
Times: 1000 hours, 1500 hours

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	64.8	64.5
	6 to 12	74.1	73.8
	12 to 24	78.2	78.0
	24 to 36	55.1	55.2
	36 to 48	53.7	53.6
Wooded Area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open Area	0 to 6	20.2	20.0
	6 to 12	7.9	7.8
	12 to 24	21.5	21.6
	24 to 36	28.3	28.4
	36 to 48	55.1	55.0
Calibration Lanes	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind Grid/Moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Demonstrator: Parsons
Date: 9/16/04
Times: 1100 hours, 1400 hours

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	64.3	64.2
	6 to 12	73.7	73.6
	12 to 24	77.8	77.8
	24 to 36	54.7	54.8
	36 to 48	53.5	53.5
Wooded Area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open Area	0 to 6	19.7	19.6
	6 to 12	7.6	7.6
	12 to 24	21.4	21.3
	24 to 36	28.2	28.1
	36 to 48	54.7	54.5
Calibration Lanes	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind Grid/Moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Demonstrator: Parsons
Date: 9/17/04
Times: 0900 hours, 1300 hours

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	64.5	64.6
	6 to 12	73.8	73.5
	12 to 24	77.6	77.5
	24 to 36	54.5	54.3
	36 to 48	53.4	53.2
Wooded Area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open Area	0 to 6	19.8	19.7
	6 to 12	7.8	7.5
	12 to 24	21.5	21.2
	24 to 36	28.0	27.9
	36 to 48	54.6	54.4
Calibration Lanes	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind Grid/Moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Demonstrator: Parsons
Date: 9/20/04
Times: 1030 hours, 1510 hours

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	65.1	65.0
	6 to 12	73.5	73.4
	12 to 24	77.4	77.1
	24 to 36	54.8	54.5
	36 to 48	53.7	53.8
Wooded Area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open Area	0 to 6	20.8	20.7
	6 to 12	7.9	7.7
	12 to 24	21.6	21.8
	24 to 36	28.8	28.5
	36 to 48	54.8	54.7
Calibration Lanes	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind Grid/Moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Demonstrator: Parsons
Date: 9/21/04
Times: 0945 hours, 1345 hours

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	65.1	65.0
	6 to 12	73.5	73.4
	12 to 24	77.4	77.1
	24 to 36	54.8	54.5
	36 to 48	53.7	53.8
Wooded Area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open Area	0 to 6	20.8	20.7
	6 to 12	7.9	7.7
	12 to 24	21.6	21.8
	24 to 36	28.8	28.5
	36 to 48	54.8	54.7
Calibration Lanes	0 to 6	2.8	
	6 to 12	15.6	
	12 to 24	25.7	
	24 to 36	33.5	
	36 to 48	39.1	
Blind Grid/Moguls	0 to 6	5.2	5.1
	6 to 12	2.1	1.9
	12 to 24	26.3	26.4
	24 to 36	36.2	36.0
	36 to 48	41.2	41.1

Demonstrator: Parsons
Date: 9/22/04
Times: 1020 hours, 1315 hours

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	65.1	65.0
	6 to 12	73.5	73.4
	12 to 24	77.4	77.1
	24 to 36	54.8	54.5
	36 to 48	53.7	53.8
Wooded Area	0 to 6	12.8	12.7
	6 to 12	6.2	6.0
	12 to 24	7.1	6.9
	24 to 36	58.2	58.1
	36 to 48	59.3	59.4
Open Area	0 to 6	20.8	20.7
	6 to 12	7.9	7.7
	12 to 24	21.6	21.8
	24 to 36	28.8	28.5
	36 to 48	54.8	54.7
Calibration Lanes	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind Grid/Moguls	0 to 6	5.1	5.0
	6 to 12	1.7	1.5
	12 to 24	26.2	26.0
	24 to 36	35.7	35.4
	36 to 48	41.0	41.0

Demonstrator: Parsons
Date: 923/04
Times: 1025 hours, 1530 hours

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	64.6	64.5
	6 to 12	73.2	73.2
	12 to 24	76.8	76.7
	24 to 36	54.2	53.9
	36 to 48	53.5	53.4
Wooded Area	0 to 6	12.5	12.4
	6 to 12	5.8	5.7
	12 to 24	6.8	6.7
	24 to 36	57.6	57.5
	36 to 48	58.9	58.8
Open Area	0 to 6	20.4	20.4
	6 to 12	7.4	7.3
	12 to 24	21.5	21.4
	24 to 36	28.5	28.3
	36 to 48	54.9	54.5
Calibration Lanes	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind Grid/Moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Demonstrator: Parsons
Date: 9/24/04
Times: 0940 hours, 1445 hours

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	64.3	64.1
	6 to 12	72.8	72.7
	12 to 24	76.4	76.3
	24 to 36	53.4	53.4
	36 to 48	53.1	52.9
Wooded Area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open Area	0 to 6	20.2	20.1
	6 to 12	7.1	7.1
	12 to 24	21.2	21.3
	24 to 36	28.1	27.9
	36 to 48	54.4	54.3
Calibration Lanes	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind Grid/Moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Demonstrator: Parsons
Date: 9/27/04
Times: 1020 hours, 1410 hours

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	63.8	63.7
	6 to 12	72.5	72.4
	12 to 24	76.2	76.2
	24 to 36	53.1	53.0
	36 to 48	52.7	52.6
Wooded Area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open Area	0 to 6	20.0	19.8
	6 to 12	6.9	6.8
	12 to 24	21.1	21.0
	24 to 36	27.7	27.5
	36 to 48	54.0	53.8
Calibration Lanes	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind Grid/Moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Demonstrator: Parsons
Date: 9/28/04
Times: 1000 hours, 1300 hours

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	63.6	
	6 to 12	72.1	
	12 to 24	76.1	
	24 to 36	53.3	
	36 to 48	52.0	
Wooded Area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open Area	0 to 6	20.7	
	6 to 12	7.3	
	12 to 24	20.9	
	24 to 36	27.5	
	36 to 48	53.7	
Calibration Lanes	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind Grid/Moguls	0 to 6	5.4	5.3
	6 to 12	1.4	1.5
	12 to 24	26.0	25.8
	24 to 36	35.9	35.7
	36 to 48	40.8	40.5

Demonstrator: Parsons
Date: 9/29/04
Times: 1020 hours, 1315 hours

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6	65.9	
	6 to 12	73.9	
	12 to 24	76.9	
	24 to 36	53.9	
	36 to 48	53.5	
Wooded Area	0 to 6		14.2
	6 to 12		6.8
	12 to 24		6.7
	24 to 36		57.9
	36 to 48		59.9
Open Area	0 to 6	22.3	
	6 to 12	7.8	
	12 to 24	21.8	
	24 to 36	28.7	
	36 to 48	54.8	
Calibration Lanes	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind Grid/Moguls	0 to 6	6.9	
	6 to 12	2.8	
	12 to 24	26.9	
	24 to 36	36.8	
	36 to 48	42.1	

Demonstrator: Parsons
Date: 9/30/04
Times: 1020 hours, 1315 hours

Probe Location:	Layer, in.	AM Reading, %	PM Reading, %
Wet Area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Wooded Area	0 to 6	14.3	14.2
	6 to 12	6.9	6.7
	12 to 24	6.8	6.4
	24 to 36	57.7	57.5
	36 to 48	59.7	59.6
Open Area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Calibration Lanes	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind Grid/Moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

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Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration min	Operational Status	OP Stat Code	Operational Status - Comments	Track Method	Track Method = Other Explain	Pattern	Field Conditions	
TEAM 1													
9/14/04	3	CALIBRATION LANE	0845	1025	100	INITIAL MOBILIZATION	1	INITIAL MOBILIZATION	GPS	NA	LINEAR	CLOUDY	MUDDY
9/14/04	3	CALIBRATION LANE	1025	1045	25	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	CLOUDY	MUDDY
9/14/04	3	CALIBRATION LANE	1045	1140	55	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
9/14/04	3	BLIND TEST GRID	1140	1515	215	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	CLOUDY	MUDDY
9/14/04	3	BLIND TEST GRID	1515	1540	25	DAILY START STOP	3	BREAKDOWN END OF OPERATIONS	GPS	NA	LINEAR	CLOUDY	MUDDY
9/15/04	4	OPEN FIELD	0745	1200	255	DAILY START STOP	3	SET UP GRIDS	GPS	NA	LINEAR	RAINY	MUDDY
9/15/04	4	OPEN FIELD	1200	1250	50	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	RAINY	MUDDY
9/15/04	4	OPEN FIELD	1250	1325	35	DAILY START STOP	3	SET UP GRIDS	GPS	NA	LINEAR	RAINY	MUDDY
9/15/04	4	OPEN FIELD	1325	1340	15	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	RAINY	MUDDY
9/15/04	2	OPEN FIELD	1340	1610	150	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	RAINY	MUDDY
9/15/04	2	OPEN FIELD	1610	1620	10	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	RAINY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration min	Operational Status	OP Stat Code	Operational Status - Comments	Track Method	Track Method = Other Explain	Pattern	Field Conditions	
9/15/04	2	OPEN FIELD	1620	1645	25	DAILY START STOP	3	BREAKDOWN END OF OPERATIONS	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	2	OPEN FIELD	0750	0820	30	DAILY START STOP	3	SET UP OPERATIONS	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	2	OPEN FIELD	0820	0830	10	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	2	OPEN FIELD	0830	1020	110	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	2	OPEN FIELD	1020	1055	35	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	2	OPEN FIELD	1055	1150	55	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	2	OPEN FIELD	1150	1240	50	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	2	OPEN FIELD	1240	1335	55	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	2	OPEN FIELD	1335	1415	40	DOWNTIME MAINTENANCE CHECK	7	CHANGE BATTERY	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	2	OPEN FIELD	1415	1505	50	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	2	OPEN FIELD	1505	1525	20	DOWNTIME MAINTENANCE CHECK	7	CHANGE BATTERY	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	2	OPEN FIELD	1525	1600	35	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	RAINY	MUDDY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration min	Operational Status	OP Stat Code	Operational Status - Comments	Track Method	Track Method = Other Explain	Pattern	Field Conditions	
9/16/04	2	OPEN FIELD	1600	1630	30	DAILY START STOP	3	BREAKDOWN END OF OPERATIONS	GPS	NA	LINEAR	RAINY	MUDDY
9/17/04	4	OPEN FIELD	0755	0810	15	DAILY START STOP	3	SET UP OPERATIONS	GPS	NA	LINEAR	RAINY	MUDDY
9/17/04	4	OPEN FIELD	0810	0815	5	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	RAINY	MUDDY
9/17/04	4	OPEN FIELD	0815	1020	125	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	RAINY	MUDDY
9/17/04	4	OPEN FIELD	1020	1045	25	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	RAINY	MUDDY
9/17/04	4	OPEN FIELD	1045	1210	85	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	RAINY	MUDDY
9/17/04	4	OPEN FIELD	1210	1250	40	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	RAINY	MUDDY
9/17/04	4	OPEN FIELD	1250	1340	50	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	RAINY	MUDDY
9/17/04	4	OPEN FIELD	1340	1405	25	DAILY START STOP	3	BREAKDOWN END OF OPERATIONS	GPS	NA	LINEAR	RAINY	MUDDY
9/20/04	3	OPEN FIELD	0750	0815	25	DAILY START STOP	3	SET UP OPERATIONS	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	0815	0825	10	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	0825	0955	90	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration min	Operational Status	OP Stat Code	Operational Status - Comments	Track Method	Track Method = Other Explain	Pattern	Field Conditions	
9/20/04	3	OPEN FIELD	0955	1045	50	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	1045	1110	25	DAILY START STOP	3	SET UP GRIDS	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	1110	1200	50	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	1200	1245	45	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	1245	1345	60	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	1345	1410	25	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	1410	1600	110	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	1600	1605	5	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	1605	1620	15	DAILY START STOP	3	BREAKDOWN END OF OPERATIONS	GPS	NA	LINEAR	SUNNY	MUDDY
TEAM 2													
9/15/04	2	OPEN FIELD	1340	1610	150	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	RAINY	MUDDY
9/15/04	2	OPEN FIELD	1610	1620	10	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	RAINY	MUDDY
9/15/04	2	OPEN FIELD	1620	1645	25	DAILY START STOP	3	BREAKDOWN END OF OPERATIONS	GPS	NA	LINEAR	RAINY	MUDDY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration min	Operational Status	OP Stat Code	Operational Status - Comments	Track Method	Track Method = Other Explain	Pattern	Field Conditions	
9/16/04	3	OPEN FIELD	0750	0820	30	DAILY START STOP	3	SET UP OPERATIONS	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	3	OPEN FIELD	0820	0830	10	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	3	OPEN FIELD	0830	0955	85	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	3	OPEN FIELD	0955	1020	25	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	3	OPEN FIELD	1020	1115	55	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	3	OPEN FIELD	1115	1150	35	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	3	OPEN FIELD	1150	1530	220	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	RAINY	MUDDY
9/16/04	3	OPEN FIELD	1530	1630	60	DAILY START STOP	3	BREAKDOWN END OF OPERATIONS	GPS	NA	LINEAR	RAINY	MUDDY
9/20/04	3	OPEN FIELD	0750	0810	20	DAILY START STOP	3	SET UP OPERATIONS	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	0810	0820	10	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	0820	1050	150	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	1050	1115	25	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration min	Operational Status	OP Stat Code	Operational Status - Comments	Track Method	Track Method = Other Explain	Pattern	Field Conditions	
9/20/04	3	OPEN FIELD	1115	1235	80	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	1235	1325	50	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	1325	1600	155	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	1600	1605	5	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	SUNNY	MUDDY
9/20/04	3	OPEN FIELD	1605	1620	15	DAILY START STOP	3	BREAKDOWN END OF OPERATIONS	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	OPEN FIELD	0800	0810	10	DAILY START STOP	3	SET UP OPERATIONS	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	OPEN FIELD	0810	0820	10	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	OPEN FIELD	0820	1035	135	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	OPEN FIELD	1035	1110	35	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	OPEN FIELD	1110	1215	65	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	OPEN FIELD	1215	1355	100	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	MOGULS	1350	1410	20	DAILY START STOP	3	SET UP GRIDS	GPS	NA	LINEAR	SUNNY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration min	Operational Status	OP Stat Code	Operational Status - Comments	Track Method	Track Method = Other Explain	Pattern	Field Conditions	
9/21/04	3	MOGULS	1410	1600	110	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	MOGULS	1600	1615	15	DAILY START STOP	3	BREAKDOWN END OF OPERATIONS	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	MOGULS	0740	0810	30	DAILY START STOP	3	SET UP OPERATIONS	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	MOGULS	0810	0815	5	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	MOGULS	0815	0950	95	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	MOGULS	0950	1030	40	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	WOODS	1030	1150	80	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	WOODS	1150	1335	105	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	WOODS	1335	1550	135	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	WOODS	1550	1600	10	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	WOODS	1600	1615	15	DAILY START STOP	3	BREAKDOWN END OF OPERATIONS	GPS	NA	LINEAR	SUNNY	MUDDY
9/23/04	5	WOODS	0750	0815	25	DAILY START STOP	3	SET UP OPERATIONS	GPS	NA	LINEAR	SUNNY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration min	Operational Status	OP Stat Code	Operational Status - Comments	Track Method	Track Method = Other Explain	Pattern	Field Conditions	
9/23/04	5	WOODS	0815	0830	15	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	SUNNY	MUDDY
9/23/04	5	WOODS	0830	1010	100	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/23/04	5	WOODS	1010	1045	25	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
9/23/04	5	WOODS	1045	1155	70	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/23/04	5	WOODS	1155	1345	110	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
TEAM 1													
9/21/04	3	OPEN FIELD	0800	0815	15	DAILY START STOP	3	SET UP OPERATIONS	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	OPEN FIELD	0815	0825	10	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	OPEN FIELD	0825	1020	115	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	OPEN FIELD	1020	1100	40	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	OPEN FIELD	1100	1140	40	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	OPEN FIELD	1140	1355	135	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	MOGULS	1355	1605	130	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration min	Operational Status	OP Stat Code	Operational Status - Comments	Track Method	Track Method = Other Explain	Pattern	Field Conditions	
9/21/04	3	MOGULS	1605	1610	5	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	SUNNY	MUDDY
9/21/04	3	MOGULS	1610	1620	10	DAILY START STOP	3	BREAKDOWN END OF OPERATIONS	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	MOGULS	0740	0825	45	DAILY START STOP	3	SET UP OPERATIONS	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	MOGULS	0825	0830	5	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	MOGULS	0830	0935	65	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	MOGULS	935	1015	40	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	MOGULS	1015	1200	105	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	MOGULS	1200	1335	95	LUNCH/BREAK	5	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	MOGULS	1335	1430	55	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/22/04	3	MOGULS	1430	1515	45	DAILY START STOP	3	BREAKDOWN END OF OPERATIONS	GPS	NA	LINEAR	SUNNY	MUDDY
9/23/04	5	WOODS	1345	1515	90	COLLECT DATA	4	COLLECT DATA	GPS	NA	LINEAR	SUNNY	MUDDY
9/23/04	5	WOODS	1515	1525	10	CALIBRATE	2	CALIBRATE USING SHOTPUT	GPS	NA	LINEAR	SUNNY	MUDDY
9/23/04	5	WOODS	1525	1620	55	DEMOBILIZATION	10	DEMOBILIZATION	GPS	NA	LINEAR	SUNNY	MUDDY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

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APPENDIX E. REFERENCES

1. Standardized UXO Technology Demonstration Site Handbook, DTC Project No. 8-CO-160-000-473, Report No. ATC-8349, March 2002.

2. Aberdeen Proving Ground Soil Survey Report, October 1998.

3. Data Summary, UXO Standardized Test Site: APG Soils Description, May 2002.

4. Yuma Proving Ground Soil Survey Report, May 2003.

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APPENDIX F. ABBREVIATIONS

AEC	=	U.S. Army Environmental Center
APG	=	Aberdeen Proving Ground
ASCII	=	American Standard Code for Information Interchange.
ATC	=	U.S. Army Aberdeen Test Center
EM	=	electromagnetic
EMI	=	electromagnetic interference
EMIS	=	Electromagnetic Induction Spectroscopy
ERDC	=	U.S. Army Corps of Engineers Engineering Research and Development Center
ESTCP	=	Environmental Security Technology Certification Program
EQT	=	Army Environmental Quality Technology Program
GPS	=	Global Positioning System
JPG	=	Jefferson Proving Ground
POC	=	point of contact
QA	=	quality assurance
QC	=	quality control
ROC	=	receiver-operating characteristic
RTK	=	real time kinematic
RTS	=	Robotic Total Station
SERDP	=	Strategic Environmental Research and Development Program
UTM	=	Universal Transverse Mercator
UXO	=	unexploded ordnance
YPG	=	U.S. Army Yuma Proving Ground

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